Relationship between Dyslipidemia, Cultural Factors, and Cardiorespiratory Fitness in Schoolchildren

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Abstract

Background: **The presence of dyslipidemia and behavioral aspects are determinants of cardiovascular risk, especially in childhood and adolescence.**

Objective: **To verify possible relationships between dyslipidemia, cultural factors, and cardiorespiratory fitness (CRF) in schoolchildren.**

Methods: **This cross-sectional study evaluated a sample of 1,254 children and adolescents between the ages of 7 and 17 from the South of Brazil, 686 of whom were female. Dyslipidemia was defined as increased levels of at least one of the following lipid profile parameters: triglycerides (TG), total cholesterol (TC) and fractions of high (HDL-c) and low-density lipoprotein (LDL-c). Cultural aspects were evaluated by a self-reported questionnaire. Data were analyzed by logistic regression, considering the odds ratios (OR) and confidence intervals (CI) at 95%.**

Results: **The results revealed a high prevalence of dyslipidemia (41.9%), which was associated with female sex (OR: 1.56; IC: 1.24–1.96) and overweight/obese status (OR: 1.55; IC: 1.20–2.00). When lipid profile parameters were evaluated separately, high levels of LDL-c were observed to be associated with sedentary school transport (OR: 1.59; IC: 1.20–2.09). Schoolchildren who were overweight/obese had higher chances of elevated levels of TC (OR: 1.40; IC: 1.07–1.84) and TG (OR: 3.21; IC: 1.96–5.26). HDL-c was shown to be related to high television time (OR: 1.59; IC: 1.00–2.54).**

Conclusion: **Alterations in lipid parameters are associated with cultural factors, especially those related to sedentary lifestyle and low levels of CRF. (Arq Bras Cardiol. 2019; 112(6):729-736)**

Keywords: **Dyslipidemias/physiopathology; Child; Adolescent; Life Style; Risk Factors; Atherosclerosis.**

Introduction

Dyslipidemia in childhood and adolescence has been the object of diverse studies, owing to its high prevalence in these age groups and to the fact that it is a predictor of atherosclerosis in adulthood.[1-3] Data from a study conducted in the United States during the period 2011–2012 indicate that approximately 1 in every 5 children and adolescents between the ages of 6 and 7 had adverse blood lipid concentrations.[4]

Subsequent studies have indicated that the occurrence of dyslipidemia during childhood and adolescence is associated with cardiovascular events[5] and cardiorespiratory fitness (CRF).[6] Similarly, behavioral aspects involving eating habits and a sedentary lifestyle, with reduced caloric expenditure and physical activity, as well as more time spent using television (TV), computers, and cellular phones, have been introduced as important determining factors for cardiovascular risk in children and adolescents.[7]

From this point of view, analyzing changes related to these conditions during childhood and adolescence is a strategy capable of reducing the incidence of injuries and preventing the occurrence of chronic diseases in subsequent years of life,[8,9] thus proposing subsidies for the development of programs that aim to maintain and promote health. With the aim of contributing to efforts to overcome these deficiencies, the objective of this study was to verify possible relations between dyslipidemia, cultural factors (eating habits, TV, school transport) and CRF in schoolchildren.

Methods

This cross-sectional study involved the participation of 1,254 children and adolescents (ages 7 to 17), 686 of whom were female, from 19 public and private school in the municipality of Santa Cruz do Sul, Rio Grande do Sul, Brazil, selected by conglomerate sampling from a population of 20,540 schoolchildren from rural and urban areas.

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Participating schools were randomly selected in the year 2004, in the beginning of the "Schoolchildren's Health" longitudinal study, in line with the population density of schoolchildren in the municipality. During the following cross-sectional analyses, all of the schoolchildren from the previously selected schools were invited to participate in the study. The initial sample was made up of 1,949 schoolchildren. However, 695 schoolchildren were excluded for the following reasons: refusal/impossibility of blood collection, non-completion of fasting period before blood collection, failure to perform the CRF test, or incomplete filling out of questionnaire form. This study is part of the "Schoolchildren's Health" study, which was approved by the Human Research Ethics Committee under certificate number 2525/10. This study follows the principles set forth by the Declaration of Helsinki. The schoolchildren's parents or legal guardians signed free and informed consent forms.

The sample size was calculated using the program G*Power 3.1 (Heinrich-Heine-Universität, Düsseldorf, Germany), using logistic regression as a statistical test (presence versus absence of dyslipidemia as dependent variable). Considering a statistical power of $(1 - \beta) = 0.95$, a significance level of $\alpha = 0.05$ and an odds ratio of 1.30, the minimum sample size estimated was 988 schoolchildren.

Blood samples were collected after a 12-hour fasting period. Serum samples were used to determine triglycerides (TG), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL-c). The tests were carried out using Miura One automated equipment (I.S.E., Rome, Italy). Low-density lipoprotein cholesterol (LDL-c) levels were calculated using the Friedewald, Fredrickson, and Levy formula.[10] International cutoff points were used to classify the lipid profile.[11] Dyslipidemia was considered as the presence of alterations in at least one component of the lipid profile (increased TG, TC, or LDL-c or decreased HDL-c, without considering borderline cases).

Levels of CRF were evaluated by the 12-minute run/walk test, recommended by the Projeto Esporte Brasil (Brazil Sport Project; PROESP-BR),[12] which consists of covering the longest distance possible in 12 minutes on a previously marked track. Researchers with degrees in Physical Education who are a part of this study applied the test, with assistance from previously trained students of Physical Education receiving scholarships. Schoolchildren were instructed to wear light clothing and tennis shoes on evaluation day. Data were classified using cutoff points defined by PROESP-BR.[12]

Cultural habits were evaluated using the adapted Barros and Nahas questionnaire,[13] which was self-reported by the schoolchildren. Amount of time spent watching TV was categorized into two categories: 1) less than two hours per day and 2) two hours per day or more. School transport was considered either active (by foot or by bike) or sedentary (car, motorcycle, or collective transport). Eating habits were evaluated by the weekly frequency with which schoolchildren consumed the following foods: 1) sweets, 2) soft drinks, 3) fried salty snacks, and 4) pizza/lasagna. Consumption was classified as "never/sometimes" (not at all/once a week) and "almost always/always" (twice or more than twice weekly).

Statistical Analysis

Data analysis was carried out using the statistical program SPSS v. 23.0 (IBM, Armonk, USA). Descriptive data were expressed in absolute and relative frequency. The association between dependent variables (dyslipidemia and increased levels of any lipid profile parameter) and cultural habits was tested via logistic regression. Values were described in odds ratios (OR) and confidence intervals (CI) at 95%. Initially, univariate analysis of data was conducted. Subsequently, adjusted analysis of variables that showed significance was applied. Data with $p < 0.05$ were considered significant.

Results

Descriptive data are shown in Table 1. Dyslipidemia was observed in 41.9% of schoolchildren. The condition was more prevalent in females, adolescents, and schoolchildren with low CRF levels ($p < 0.05$).

The data described in Table 2 indicate that dyslipidemia was significantly associated with female sex and overweight/obese status. Adolescents had lower chances of developing dyslipidemia, in comparison with children. In the univariate analysis, low levels of CRF were associated with dyslipidemia. This association, however, was not maintained in the multivariate analysis. Furthermore, cultural aspects were not associated with dyslipidemia.

When comparing data for lipid profile components, in as isolated manner, high levels of TC were observed to be associated with female sex. Adolescents had higher chances of increased TC and TG levels than children. Overweight/obese status is associated with increased TC and TG (Table 3).

Low levels of HDL-c are associated with the habit of watching TV for 2 or more hours per day. Female sex, adolescent age range, and sedentary school transport were associated with increased LDL-c (Table 4).

Discussion

A high prevalence of dyslipidemia in schoolchildren has constituted increasingly frequent alterations in Brazilian children and adolescents. Studies conducted in Recife, Pernambuco (29.7%),[14] Florianópolis, Santa Catarina (22.0%),[15] and Londrina, Paraná (20.8%)[16] indicate a growing prevalence of dyslipidemia in schoolchildren in different regions of the country. In Birjand, Iran, similar estimates indicated that the prevalence of dyslipidemia has affected 31% of children between 6 and 11 years of age, with girls presenting a higher prevalence of hypertriglyceridemia and boys a higher prevalence of hypercholesterolemia.[17] It is worth highlighting, however, that the high prevalence found in this study (41.9%) exceeds these already high estimates. Furthermore, data from a 10-year trend study (2004–2014) of serum lipid levels and dyslipidemia, conducted with 3,249 schoolchildren between the ages of 6 and 18 from several schools in Beijing, demonstrated that the prevalence of dyslipidemia, based on elevated levels of TG and TC and reduced HDL-c, significantly increased during the period. This suggests an upward trend in this prevalence and constitutes a warning that continuous measures are necessary to curb this condition.[18]

Table 1 – Description of results regarding variables studied in schoolchildren in Santa Cruz do Sul, RS

Variables	Total (n = 1,254)	Presence of dyslipidemia (n = 526)	Absence of dyslipidemia (n = 728)	p
	n (%)	n (%)	n (%)	
Sex				
Male	568 (45.3)	208 (39.5)	360 (49.5)	0.001
Female	686 (54.7)	318 (60.5)	368 (50.5)	
Age range				
7 to 9 years old (children)	344 (27.4)	166 (31.6)	178 (24.5)	0.005
10 to 17 years old (adolescents)	910 (72.6)	360 (68.4)	550 (75.5)	
TV				
Less than 2 hours	697 (55.6)	303 (57.6)	394 (54.1)	0.221
2 hours or more	557 (44.4)	223 (42.4)	334 (45.9)	
School transport type				
Active	558 (44.5)	234 (44.5)	324 (44.5)	0.995
Sedentary	696 (55.5)	292 (55.5)	404 (55.5)	
Avoids eating fatty or sweet foods				
Never/sometimes	917 (73.1)	377 (71.7)	540 (74.2)	0.324
Almost always/always	337 (26.9)	149 (28.3)	188 (25.8)	
4 to 5 varied meals per day				
Never/sometimes	583 (46.5)	249 (47.3)	334 (45.9)	0.609
Almost always/always	671 (53.5)	277 (52.7)	394 (54.1)	
Consumption of soft drinks				
Never/sometimes	492 (39.2)	220 (41.8)	272 (37.4)	0.110
Almost always/always	762 (60.8)	306 (58.2)	456 (62.6)	
Consumption of fried salty snacks				
Never/sometimes	639 (51.0)	273 (51.9)	366 (50.3)	0.570
Almost always/always	615 (49.0)	253 (48.1)	362 (49.7)	
Consumption of pizza and lasagna				
Never/sometimes	897 (71.5)	391 (74.3)	506 (69.5)	0.061
Almost always/always	357 (28.5)	135 (25.7)	222 (30.5)	
Consumption of sweets				
Never/sometimes	500 (39.9)	211 (40.1)	289 (39.7)	0.882
Almost always/always	754 (60.1)	315 (59.9)	439 (60.3)	
Cardiorespiratory fitness				
At risk	637 (50.8)	285 (54.2)	352 (48.4)	0.042
Normal	617 (49.2)	241 (45.8)	376 (51.6)	

TV: television.

Regarding factors that contribute to high rates of dyslipidemia, our findings showed an association with the presence of overweight/obese status and sedentary behavior. On the other hand, various factors have been indicated as contributing to the occurrence of altered blood lipid concentrations. Alcântara Neto et al.[19] indicate that there is a positive association between inadequate food intake and dyslipidemia. Body mass index (BMI) is also an important variable, given that obesity has been evidenced as an important risk factor for dyslipidemia and cardiometabolic risk. This suggests that obese adolescents have elevated levels of TG, TC, LDL-c, increased insulin resistance, and reduced levels of HDL-c.[20] Moreover, a cross-sectional study of 173 schoolchildren ages 10–18, demonstrated that greater adherence to a diet high in fat and sugar was associated with the presence of hypercholesterolemia (OR: 1.6; 95% CI: 1.1–2.3) and increased LDL-c (OR: 1.7; 95% CI: 1.0–2.9). Furthermore, children who exercised less than 3 times/week were less likely to have low levels of HDL-c than children who exercised 7 times/week or more (OR: 0.4; 95% CI: 0.2–0.7).[21]

Table 2 – Association between dyslipidemia and demographic data, cardiorespiratory fitness, and cultural habits in Santa Cruz do Sul, RS

Variables	Dyslipidemia Crude OR[1] (95% CI)	Dyslipidemia Adjusted OR[2] (95% CI)
Sex		
Male		
Female	1.50 (1.19–1.88)*	1.56 (1.24–1.96)*
Age range		
7 to 9 years		
10 to 17 years	0.70 (0.55–0.90)*	0.72 (0.56–0.93)*
TV		
Less than 2 hours		–
2 hours or more	0.87 (0.69–1.08)	
School transport type		
Active		–
Sedentary	1.00 (0.80–1.25)	
Cardiorespiratory fitness		
Normal		
At risk	1.26 (1.01–1.58)*	1.18 (0.93–1.48)*
BMI classification		
Underweight/normal		
Overweight/obese	1.60 (1.25–2.05)*	1.55 (1.20–2.00)*
Avoids eating fatty or sweet foods		
Never/sometimes		–
Almost always/always	0.88 (0.68–1.13)	
Varied meals		
Never/sometimes		–
Almost always/always	1.06 (0.85–1.33)	
Soft drinks		
Never/sometimes		–
Almost always/always	0.83 (0.66–1.04)	
Pizza or lasagna		
Never/sometimes		–
Almost always/always	0.79 (0.61–1.01)	
Sweets		
Never/sometimes		–
Almost always/always	0.98 (0.78–1.24)	
Fried salty snacks		
Never/sometimes		–
Almost always/always	0.94 (0.75–1.17)	

*Logistic regression. OR: odds ratio; CI: 95% confidence interval; TV: television; BMI: body mass index. [1]Univariate analysis; [2]analysis adjusted for variables that showed significance (p < 0.05). *Significant data (p < 0.05).*

A study of 1,805 Chinese children and adolescents evaluated the different between metabolically healthy and metabolically unhealthy schoolchildren. The findings revealed that BMI and sedentary behavior were the factors with the greatest impact on metabolic health. In addition, excessive consumption of junk food was strongly associated with unfavorable metabolic profiles in schoolchildren.[22] Similarly, a study of 227 preschool children conducted in Diamantina, Minas Gerais, Brazil demonstrated that preschoolers who reported less balanced diets, with more frequent consumption of foods rich in lipids and carbohydrates, as well as higher BMI and lower levels of maternal education, had a higher association with the occurrence of lipid profile

Table 3 – Association between altered triglycerides and total cholesterol and demographic data, cardiorespiratory fitness, and cultural habits in Santa Cruz do Sul, RS

Variables	CT Crude OR[1] (95% CI)	CT Adjusted OR[2] (95% CI)	TG Crude OR[1] (95% CI)	TG Adjusted OR[2] (95% CI)
Sex				
Male				–
Female	1.29 (1.01–1.66)*	1.36 (1.05–1.75)*	1.53 (0.94–2.51)	
Age range				
7 to 9 years				
10 to 17 years	0.63 (0.48–0.83)*	0.66 (0.50–0.86)*	0.39 (0.34–0.62)*	0.47 (0.28–0.76)*
TV				
Less than 2 hours				–
2 hours or more	0.81 (0.63–1.04)	–	1.31 (0.81–2.10)	
School transport type				
Active				–
Sedentary	0.83 (0.64–1.06)	–	0.98 (0.61–1.58)	
Cardiorespiratory fitness				
Normal				–
At risk	1.24 (0.97–1.59)	–	1.50 (0.93–2.44)	
BMI classification				
Underweight/normal				
Overweight/obese	1.45 (1.11–1.90)*	1.40 (1.07–1.84)*	3.82 (2.36–6.20)*	3.21 (1.96–5.26)*
Avoids eating fatty or sweet foods				
Never/sometimes				–
Almost always/always	0.91 (0.69–1.20)	–	1.10 (0.66–1.87)	
Varied meals				
Never/sometimes				–
Almost always/always	0.92 (0.72–1.18)	–	0.70 (0.44–1.13)	
Soft drinks				
Never/sometimes				
Almost always/always	0.86 (0.67–1.11)	–	0.48 (0.30–0.78)*	0.63 (0.38–1.04)
Fried salty snacks				
Never/sometimes				
Almost always/always	0.96 (0.75–1.23)	–	0.49 (0.30–0.81)*	0.58 (0.34–0.98)*
Pizza or lasagna				
Never/sometimes				–
Almost always/always	0.93 (0.70–1.23)	–	0.58 (0.32–1.05)	
Sweets				
Never/sometimes				–
Almost always/always	0.89 (0.69–1.15)	–	0.95 (0.59–1.53)	

*Logistic regression. TC: total cholesterol; TG: triglycerides; TV: television; BMI: body mass index; OR: odds ratio; CI: 95% confidence interval. [1]Univariate analysis; [2]analysis adjusted for variables that showed significance (p < 0.05). *Significant data (p < 0.05).*

alterations, especially higher levels of LDL-c, with these variables being identified as determinants of dyslipidemia in the preschoolers evaluated.[5] It is thus understood that this condition, largely due to dietary habits, is affecting schoolchildren at increasingly early ages.

In detail, this study indicated an associated between dyslipidemia and low levels of CRF, increased LDL-c, and sedentary school transport, as well as low levels of HDL-c and more time in front of the TV. It is thus proposed that sedentarism and low CRF are associated with metabolic

Table 4 – Association between altered high and low-density lipoprotein cholesterol and demographic data, cardiorespiratory fitness, and cultural habits in Santa Cruz do Sul, RS

Variables	HDL-c Crude OR[1] (95% CI)	LDL-c Crude OR[1] (95% CI)	LDL-c Adjusted OR[2] (95% CI)
Sex			
Male			
Female	0.87 (0.54–1.38)	1.68 (1.28–2.20)*	1.65 (1.25–2.18)*
Age range			
7 to 9 years			
10 to 17 years	1.14 (0.67–1.95)	1.52 (1.11–2.09)*	1.50 (1.08–2.07)*
TV			
Less than 2 hours			–
2 hours or more	1.59 (1.00–2.54)*	0.88 (0.67–1.15)	
School transport type			
Active			1
Sedentary	0.92 (0.58–1.48)	1.63 (1.24–2.15)*	1.59 (1.20–2.09)*
Cardiorespiratory fitness			
Normal			–
At risk	1.28 (0.80–2.05)	1.08 (0.83–1.40)	
BMI classification			
Underweight/normal			–
Overweight/obese	1.55 (0.96–2.50)	1.13 (0.85–1.51)	
Avoids eating fatty or sweet foods			
Never/sometimes			–
Almost always/always	0.90 (0.53–1.54)	0.89 (0.66–1.21)	
Varied meals			
Never/sometimes			–
Almost always/always	0.81 (0.51–1.30)	1.07 (0.82–1.40)	
Soft drinks			
Never/sometimes			–
Almost always/always	0.88 (0.55–1.41)	0.78 (0.60–1.03)	
Fried salty snacks			
Never/sometimes			–
Almost always/always	0.98 (0.62–1.57)	0.88 (0.67–1.14)	
Pizza or lasagna			
Never/sometimes			–
Almost always/always	0.55 (0.30–0.99)	0.97 (0.73–1.31)	
Sweets			
Never/sometimes			–
Almost always/always	0.96 (0.60–1.54)	1.10 (0.84–1.44)	

*Logistic regression. HDL-c: high-density lipoprotein cholesterol; LDL-c: low-density lipoprotein cholesterol; TC: total cholesterol; TG: triglycerides; TV: television; BMI: body mass index; OR: odds ratio; CI: 95% confidence interval. [1]Univariate analysis; [2]analysis adjusted for variables that showed significance (p < 0.05). *Significant data (p < 0.05).*

alterations. In the same manner, results from the *National Health and Nutrition Examination Survey* (NHANES) demonstrated that screen time appears to be a potential moderator of the relationship between physical activity and cardiovascular fitness in male adolescents with dyslipidemia.[23] Furthermore, previous data, involving a sample of 1,243 children and adolescents from our municipality, demonstrated that lipid profile alterations are more prevalent among obese/unfit children and adolescents in comparison with schoolchildren with normal or low weight, in both sexes. These results reinforce the findings of the present study and indicate a direct relation between the prevalence of dyslipidemia, obesity, and low levels of CRF.[6]

Thus faced with this increasing impact of dyslipidemia on health conditions in the pediatric population, recommendations suggest that children be screened for risk factors in order to promote early identification of high levels of LDL-c and reduce cardiovascular events in young adults.[24] This notwithstanding, it is assumed that only 18% of this population receives this form of primary care.[25] The National Academy of Medicine of the United States recommends that children have access to healthy food and that parents and guardians offer nutritious foods that promote fullness. It is also necessary to increase time dedicated to practicing physical activities and reduce activities that stimulate sedentary behavior in the pediatric population.[26] With respect to treating dyslipidemia, it is estimated that changes involving lifestyle intervention are alternatives with excellent results and that they provoke positive response and adaptation, with treatment involving medication being used only in rare cases.[27] In the same manner, the results of our study suggest that these recommendations should continue during subsequent years to include the periods of adolescence and adulthood.

We recognize the fact that the questionnaire was self-reported by the schoolchildren as a limitation to this study, given that these reports may not be compatible with reality. Additionally, due to the cross-sectional design, it was not possible to show causality. The study includes the evaluations of schoolchildren in a municipality in the South of Brazil, which may not be representative of the reality of children and adolescents in other contexts. At the same time, this may be considered a strong point of our study, to the extent that it indicates that the high prevalence of dyslipidemia found corresponds to and even exceeds those which were indicated in studies in other territories of Brazil, providing a current estimate that the occurrence of this condition tends toward a growing increase. Furthermore, the study structurally explores variables that are relevant to schoolchildren's cultural context, proposing estimates and describing factors that are apparently associated with the high prevalence of dyslipidemia in children and adolescents. The data thus permit health management organizations dedicated to children and adolescents to establish more precise guidelines for this population.

Conclusion

The results of this study show that there is a high prevalence of dyslipidemia in schoolchildren and that this is related to low cardiorespiratory fitness and cultural factors, especially those related to sedentary behavior. These findings highlight the need for interventions that promote healthy habits and lifestyles, beginning with the first years of childhood.

Author contributions

Conception and design of the research: Reuter CP, Brand C, Renner JDP, Franke SIR, Burgos MS; Acquisition of data: Reuter CP, Silva PT, Reuter EM, Renner JDP, Franke SIR, Burgos LT, Schneiders LB, Burgos MS; Analysis and interpretation of the data: Reuter CP, Brand C, Silva PT, Reuter EM, Renner JDP, Franke SIR, Mello ED, Burgos LT, Schneiders LB, Burgos MS; Statistical analysis: Reuter CP, Silva PT; Writing of the manuscript and Critical revision of the manuscript for intellectual content: Reuter CP, Brand C, Silva PT, Reuter EM, Renner JDP, Franke SIR, Mello ED, Schneiders LB, Burgos MS.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Universidade Santa Cruz do Sul under the protocol number 2525/10. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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